MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
«IGOR SYKORSKY KYIV POLYTECHNIC INSTITUTE»

APPROVED BY
Deputy Director
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30.05.2018

Physics 1. Mechanics

Work Program

for students preparing the first (Bachelor) level of higher education
«Bachelor» of the specialties 113 Applied Mathematics
125 Cybersecurity

Approved by methodical commission
IPT Igor Sikorsky Kyiv Polytechnic Institute
Protocol № 6/2018 of May 24, 2018 p.
Head of methodical commission
Smirnov S.
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The work program of the credit module «Physics 1. Mechanics» for students preparing the first (Bachelor) level of higher education «Bachelor» in the speciality 125 Cybersecurity, 113 Applied mathematics, according to the full-time form of study is compiled accordingly to the program of the subject «Physics»

Developer of program of the subject:

associate professor, candidate of physical and mathematical sciences

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The program is approved at the sessions of the information security department Protocol № 5/2018 of April 25, 2018

Acting head of department

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25.04.2018

The program is approved at the sessions of the mathematical methods of information security department Protocol № 4/2018 of April 17, 2018

Head of department

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17.04.2018

Introduction

Successful interaction of educational, organizational and methodological and scientific processes in higher educational institutions is the basis for the formation of a modern student, which provides the formation of a modern specialist with a full set of knowledge through the assimilation of all three components during the study period. Through this kind of work the student acquires skills of learning, assimilation, processing and use of new information.

Physics programs are based on one of the most advanced technologies – the credit-module system, which ensures the improvement of the quality of education in the information society, the educational mobility of each student, the acquisition of self-realization and competitiveness in the labor market.

The discipline programs are aimed at maximizing the individualization of the learning process. The scientific and pedagogical staff of the department actively work on the new educational technologies of the educational process in accordance with the democratic values of modern scientific and technological achievements of the Bologna process.

The academic discipline belongs to the cycle of fundamental natural science training.

1. The purpose and tasks of the discipline

1.1. Purpose of the discipline

The basis of the credit-module technology of teaching disciplines Physics 1. Mechanics are the following principles:

1. introduction of constant stimulation of independent learning by the student of educational material;

2. ensuring the regularity and continuity of training, increasing the value and objectivity of current and final control;

3. rejection of traditional forms of assessment of students knowledge, which strongly depend on the subjective approach of the teacher;

In the study of academic disciplines, a comprehensive system approach to mastering the knowledge of the students, which allow timely adaptation to profound changes in Cyber Security technology, an increasing flow of information, and the latest scientific and technological advances in the field of information technologies, is used.

2. Structure and main tasks of the discipline

The main forms of studying the discipline Physics 1. Mechanics are lectures, practical and laboratory classes.

At lectures, students should familiarize themselves with the fundamental laws of nature, properties and structure of matter, to acquire physical theories, fundamental concepts and definitions of physical quantities, content of models, hypotheses, laws, principles, and to form a coherent modern physical picture of the world.

The material of the lecture by the teachers of the department is presented in the form of presentations using the technical means of study, which is provided by the department and the university as a whole. This form of lecture lecture provides an opportunity to provide students with broader and more in-depth information on the subject being studied, and also meets the modern requirements of innovative approaches in the methodology of teaching disciplines.

The practical lessons consolidate theoretical knowledge by solving problems and examples, assimilate the means and methods for solving specific problems from different sections of physics.

In laboratory classes, students get acquainted with the physical phenomena being investigated and laws to understand the essence of research methods, acquire the skills of assessing the technical means used in the experiment, the skills to establish the reliability of the results obtained, learn the ability to use statistical techniques and modern computer techniques for processing and analysis of the results of the experiment.

Individual work is done on teaching aids and textbooks. To facilitate students' independent work, the teacher defines the main and additional literature, provides methodological advice. Also, it is recommended for

the individual work to use electronic versions of textbooks, manuals and textbooks, prepared at the department and presented in the university's library.

For the convenience of working out and raising the level of assimilation of material in the process of independent work, at the end of each section of each discipline, control questions and a list of recommended literature are submitted. The curricula for studying disciplines are aimed at increasing the level of mastering the lecture material, developing the scientific worldview, modern physical thinking and the skills of active independent educational, scientific, methodological and practical activities, forging the ability to put the experiment and conduct its analysis, develop the thinking and creative abilities necessary for the formation high level future specialist.

To study the discipline, 150 hours/5.0ECTS credits are assigned.

Form of study	Semester	Total credits/hours	Distribution of training time by types of classes						Semester certification
			Lectures	Practical training	Seminars	Laboratory classes	Computer workshop	Self-study	
full-time	1	5.0/150	36	36		18		60	exam

3. Content of educational material

Chapter 1. Kinematics

1.1 Space and time. Reference frame. Material point. Radius vector. Trajectory, path, movement. Average and instantaneous velocity. Vector, coordinate methods for describing motion. Parametric description of the movement. Kinematics of the rotational motion. Rotational motion of a point and its angular characteristics.

1.2 Kinematics of a rigid body. Progressive, rotational, flat motion of a solid body. Motion around a fixed point. Euler's theorem;

Chapter 2. Dynamics

2.1 The concept of force. Types of interactions in modern physics. Types of forces. Newton's laws. Equation of particle motion, many-particle system. Momentum Conservation Law.

2.2 Center of mass. Theorem on the motion of the center of mass. Reference frame of the center of mass.

2.3 Equation of motion of a body with a variable mass.

2.4 Non-inertial reference frame. Inertial forces.

Chapter 3. Work and energy.

3.1 Work of force. Power of force. Potential, conservative forces. Work of conservative forces. Potential energy and its normalization. Relationship between conservative force and potential energy. Gradient.

3.2 Relationship between work of force and the change of the kinetic energy of a point. Kinetic energy of many-particle system. Kenig's theorem. Total mechanical energy conservation law. The work of dissipative forces.

Chapter 4. Angular Momentum Conservation Law.

4.1 Angular momentum, torque (moment of force). Rate of change of angular momentum for particle and many-particle systems. Angular momentum conservation.

Chapter 5. Classical central-force problem.

5.1 Central forces.

5.2 Potential energy in central force field.

5.3 Conservation Laws in central force field.

5.4 Kepler's laws of planetary motion.

Chapter 6. Rigid body dynamics.

6.1 The equation of motion of Rigid body.

6.2 Relation between angular momentum and angular velocity.

6.3 Rotation of the body relative to the fixed axis. Kinetic energy of rotating body.

6.4 The moment of inertia of a particle, many-particle system and rigid body. Parallel axis theorem (Huygens–Steiner theorem).

Chapter 7. The principle of relativity

7.1 Properties of space and time. Inertial reference systems. Galilean transformation and their effects. Postulates of the special theory of relativity. Properties of light speed in vacuum.

7.2 Postulates of the special theory of relativity (SR). Properties of light speed in vacuum;

7.3 Lorentz transformations. The interval between events. World line Light Cone of Events. Types of intervals. Consequences of the Lorentz transformations — time dilation, relativity of simultaneity, the length contraction, velocity-addition formula.

Chapter 8. Dynamics or Special Relativity Theory

8.1 Conservation of momentum and definition of relativistic momentum.

8.2 Relativistic energy. Transformation of momentum and energy.

8.3 Relativistic equation of motion.

Chapter 9. Mechanical oscillations.

9.1 Oscillatory motion and its characteristics. Equation of oscillation. Simple harmonic oscillation. Graphic representation of harmonic oscillation by the method of vector diagrams. Superposition of unidirectional oscillations, perpendicular oscillations, beats.

9.2 Representation of oscillations in a complex form. Differential equations of forced oscillations of an elastic pendulum, a mathematical and physical pendulum. Types of oscillations and their differential equations.

4. The approximative theme of practical training

The main purposes of the of practical training is to form the ability to use the knowledge of about the laws of mechanics in professional activities.

1. Kinematics of the particle.
2. Kinematics of rotational motion, kinematics of a Rigid Body.
3. Elements of Special Theory of Relativity.
4. Particle dynamics and particle systems.
5. Non-inertial frame or reference.
6. Motion of a Rigid Body with a variable mass.
7. Work and energy.
8. Conservations Laws.
9. Dynamics of a Rigid body.
10. Motion in the field of Central Forces.
11. Kinematics and Dynamics of the Special Theory of Relativity.
12. Mechanical oscillations.

5. The approximative list of laboratory classes

The main purposes of the laboratory classes are the formation of practical skills in the implementation of the experiment, processing and interpretation of its results.

During the semester, laboratory classes is carried out according to the schedule. For performing each laboratory work 3 hours — 2 for the experiment, 1 for work protection, individual work with the teacher. Topics of laboratory works:

1. Studying the motion of bodies in the field of gravity using the Atwood's machine.

2. Study of the laws of rotational motion on the example of the Oberbeck's pendulum.

3. Study of Conservation Lows of momentum and total mechanical energy on an example of collision of bullets.

4. Study of the motion of the physical pendulum.

6. Individual calculation work

In each semester, 1 calculation work is performed. It is executed as a semester problems and contains an individual set of problems of a calculated character, which covers the material of the semester. Variants of problems for the calculation work are given by the teacher at the beginning of the semester.

7. Control operations

1 Modular control work in semester.

8. Bybliography

Main

BerkeleyMechanics Ch. Kittel et al. Mechanics (Berkeley Physics Course, Vol. 1). McGraw-Hill Book Company, 1973.

BerkeleyWaves F. S. Crawford. Waves, (Berkeley Physics Course, Vol. 3). McGraw-Hill Book Company, 1968.

Holyday D. Halliday, R. Resnik, and J. Walker. Fundamentals of Physics. 10th ed. 1450 pp.

IrodovMechanics I. E. Irodov. Fundamental Laws of Mechanics. CBS publishers & distributors, 2004.

IrodovProblems I. E. Irodov. Problems in general physics. Revised. Mir Publishers, 1988.

Additional

Crowell1 B. Crowell. Mechanics. Light and Matter. eprint: http://www.lightandmatter.com/mechanics/.

FLF1 R. Feynman, R. Lejton, and M. Sends. Lectures on physics. Vol. 1. Mainly mechanics, radiation, and heat. New Millenium Edition. Basic Books, 2010. 968 pp.

9. The criterion for evaluating students' knowledge

The criterion for evaluating students' knowledge is the systemicity of general-professional knowledge, skills and abilities.

The control of students' current progress is carried out using the electronic journal, which records assessments for all types of student work, and this is the evaluation of the work in the classroom in practical classes, assessments for performing independent individual work, the protection of laboratory classes, estimates for the calculation and graphic work, modular control works. Together for the semester the student will receive more than 20 marks. Current performance is estimated at the 60-point system. At the end of each semester, the curriculum provides for a score or examination, the results of which are evaluated by the 40-point system.